Space Weather Technical Forecast

Issued on Saturday, 23 July 2022 at 13:04 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: 21 July CME shock arrived at Earth 03Z, G1 observed. Slight Chance of R1/R2. Chance of Active electron fluence into new working week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the past 24 hours, with isolated small-scale C-class activity observed at GOES16. The peak flare was a C1.8 at 23/1002UTC from AR3057 on the northwestern horizon. Prior to this, a C1.5 was observed at 22/1614UTC, with this tied to a prominence eruption from the southwestern limb, perhaps from the vicinity of Ex-3056 which is now on the far side. The resulting Coronal Mass Ejection (CME) from this event has been modelled and determined to have no Earth-bound component.

There were six numbered sunspot regions that saw out the period, with AR3063 fading to plage near centre-disc. Relative to the preceding week, the Sun seems to be undergoing something of a slight lull in numbers of sunspots and their associated activity. Having said this, minor proliferation was observed in bipolar regions AR3064 and AR3060, with growth and spreading perhaps most marked in AR3065, which reached Cro/Beta by the period's end. With an apparently opposing trend, AR3057 is now becoming difficult to discern on the western limb, and should rotate off the disc entirely by around 12 hours' time. Finally, all of the unipolar groups (Zurich Hsx) were unchanged in the period.

Available coronagraph imagery in the period suggests there were up to three separate CME-generating events: firstly, the aforementioned prominence near Ex-3056; secondly a western hemisphere far-sided event; and thirdly another far side emission from the eastern solar hemisphere. The third of these has yet to be analysed, however any Earth effects are not expected, as modelling suggests for the other events.

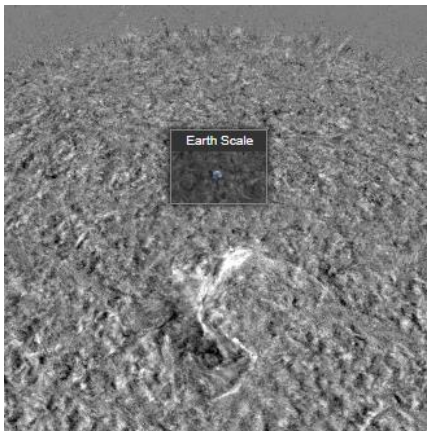

Figure 0: Helioviewer.org-generated 1-hour difference image of AIA304 to 23/0900UTC, showing possible disturbance in a centre-disc filament. As yet there is no coronagraph ejecta attributable to this event.

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At around 23/0800UTC a disturbance was seen in a filament in the northern solar hemisphere straddling the meridian. There was unfortunately no usable H-Alpha imagery for this period, however it is possible that a minor filament lift off occurred from this location, with the aftermath becoming visible at around 23/0900UTC in El Teide as a mobile filament on the disc. Coronagraph imagery will be monitored, however there is as yet no sign of ejecta.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, showed the arrival of at least the shock of the 21 July centre-disc CME in the period, passing L1 at 23/0229UTC, and reaching Earth-based magnetometers at 23/0257UTC. The CME's passage of L1 precipitated a sudden impulse warning from MOSWOC, which manifested at BGS Hartland magnetometer from 23/0227UTC as a near-instantaneous change in the H-component of 38nT, with a 50nT change seen inside three hours. The solar wind had previously shown a fast regime tied to a negative polarity coronal hole (expected to be from CH01/- and/or CH02/-).

The solar wind speed started the 24 hours at Elevated levels, mainly near 525km/s but with occasional forays as high as 575km/s. This changed with the advent of the CME, whereupon an increase to around 675km/s was seen briefly before this fell back to nearer 550km/s by the end of the reporting period. The solar wind density started near its typical single-figure ppcc background regime, but increased to a peak near 20ppcc at the onset of the CME, again paring back to more typical levels later in the UTC morning. The IMF was also within normal background at first, but peaked at 17nT with the transient, while the north-south component showed an erratic tendency with the CME between +/-13nT, although this decayed relatively quickly later in the morning. The phi angle was negative (towards the Sun) throughout.

At the time of writing, there has been no progression in the signature at L1 from a shock-like regime to a magnetic cloud-like regime, with no smooth sinusoid in Bz and with phi unmoved. It may be that this represents the sum total of this event, with the core of the CME perhaps passing narrowly behind the Earth in its orbit, however this is conjectural and any possible confirmatory signal from STEREO A is patchy at best.

The net result of the above solar wind measures was initially provisionally Quiet, but increasing to Minor Storm G1 with the CME's arrival, and a provisional Kp '5o' in the 03-06UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16, was at Background levels.

High energy electron flux started at Moderate levels, with a peak near 800pfu late in the UTC afternoon of Friday 22 July, but saw this oscillation attenuated to Normal Background after the CME onset. Electron fluence has been below the Active threshold throughout with a near-flat trend. Fluence reached 2.69e7 integrated pfu at 23/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is expected to remain mainly Low, with a slight chance of Moderate activity from a number of currently inert regions on the visible disc.

Solar Wind / Geomagnetic Activity: The 21 July CME shock arrived at Earth 23/0257UTC and its effects are ongoing, with further G1 intervals Likely for the remainder of day one, Saturday 23 July, becoming a Slight Chance on day two, Sunday 24 July before fading. No further CMEs feature in the forecast.

The only persistent feature in the forecast is the already mature influence from coronal holes 01 and 02, with their influence probably swamped by the 21 July CME for the remainder of their tenure this UTC weekend, decaying to Quiet activity into the new working week.

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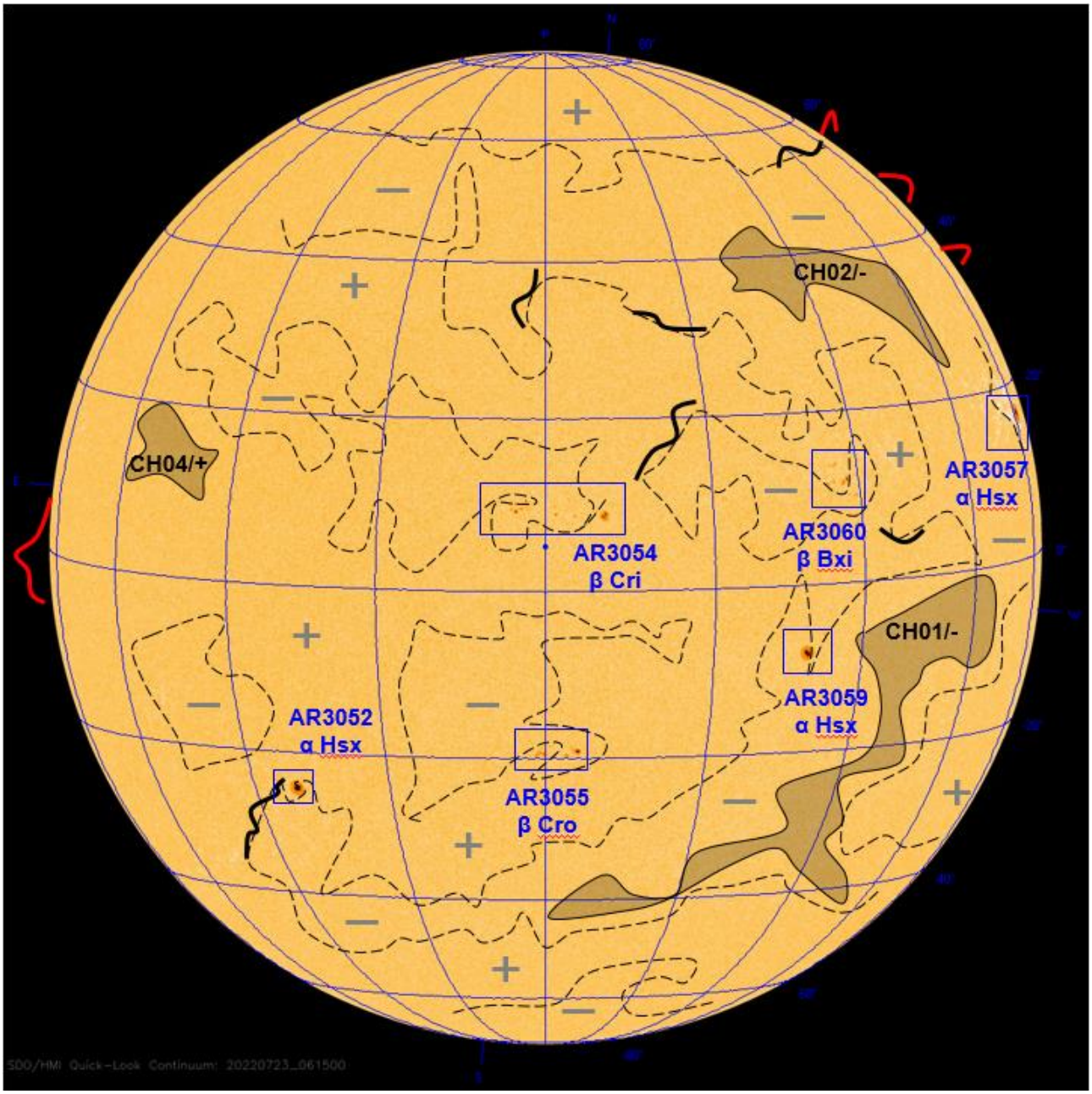
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels.

The high energy electron flux (greater than 2 MeV) is expected to be at Background on day 1 and at first on day 2 (23 and 24 July) then increase, perhaps to High levels at the diurnal peaks on days 2 and 3 (24 and 25 July) as CME effects wane. The associated fluence is expected to rise, with a chance of reaching the Active threshold (1e8 integrated pfu) on day 4.

Figure 1. Solar Analysis Valid 23/0615UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The solar wind, as observed by DSCOVR at L1, showed the arrival of at least the shock of the 21 July centre-disc CME in the period, passing L1 at 23/0229UTC, and reaching Earth-based magnetometers at 23/0257UTC.

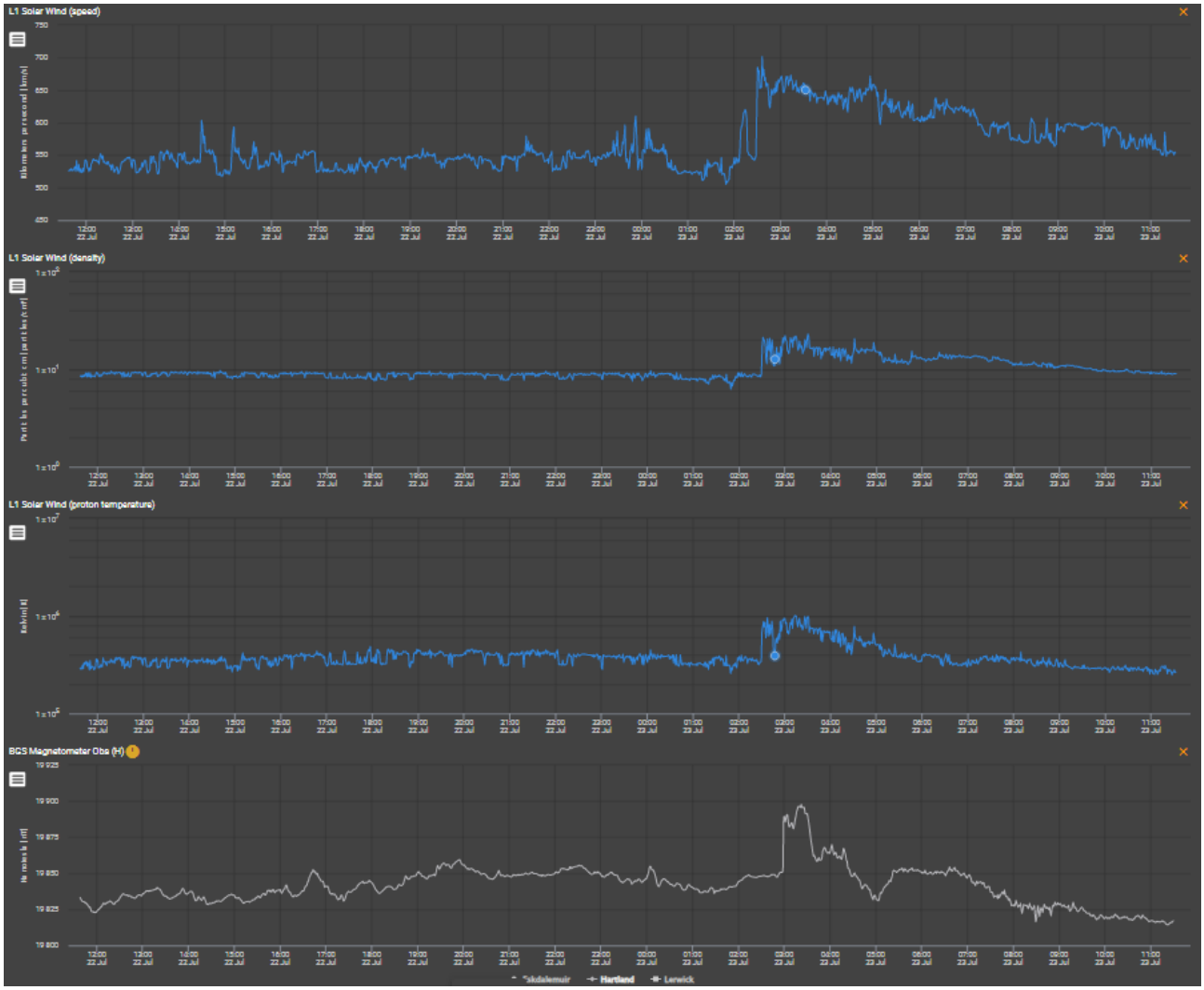

Figure 2: DSCOVR solar wind speed, density and temperature for the 21 July CME arrival at 23/0229UTC. Also shown is the resultant deflection in Hartland magnetometer's H-component trace around half an hour later.

At the time of writing, there has been no progression in the signature at L1 from a shock-like regime to a magnetic cloud-like regime, with no smooth sinusoid in Bz and with phi unmoved. It may be that this represents the sum total of this event, with the core of the CME perhaps passing narrowly behind the Earth in its orbit, however this is conjectural and any possible confirmatory signal from STEREO A is patchy at best.

The chances of further G1s will be higher should the IMF evolve into a magnetic cloud-like signature in the near future, else the protracted periods of Bz that would be required are less likely. Because this does not yet appear to be happening, the chances of further G1 intervals have been dropped slightly relative to earlier guidance, with a shorter duration also now expected. The CME should have waned by the start of the new UTC working week, with CH01 and/or CH02 probably

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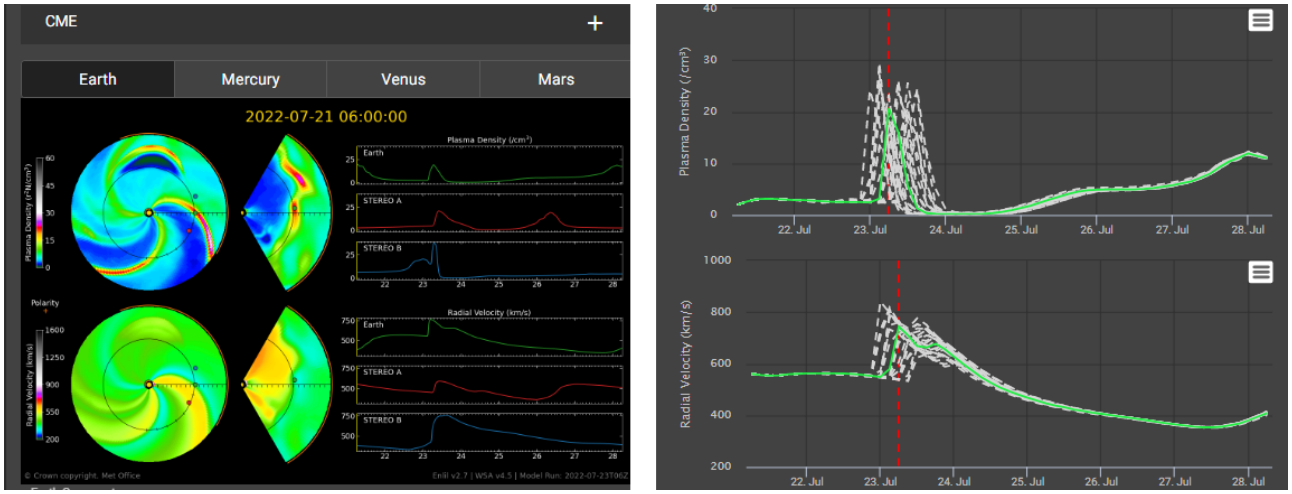
already following suit, meaning that more reliably Quiet geomagnetic conditions can be expected from day three, Monday 25 July.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	60	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 3: MOSWOC Enlil for the 21 July CME, showing the observed arrival time of around 23/0300UTC to be an almost exact match.



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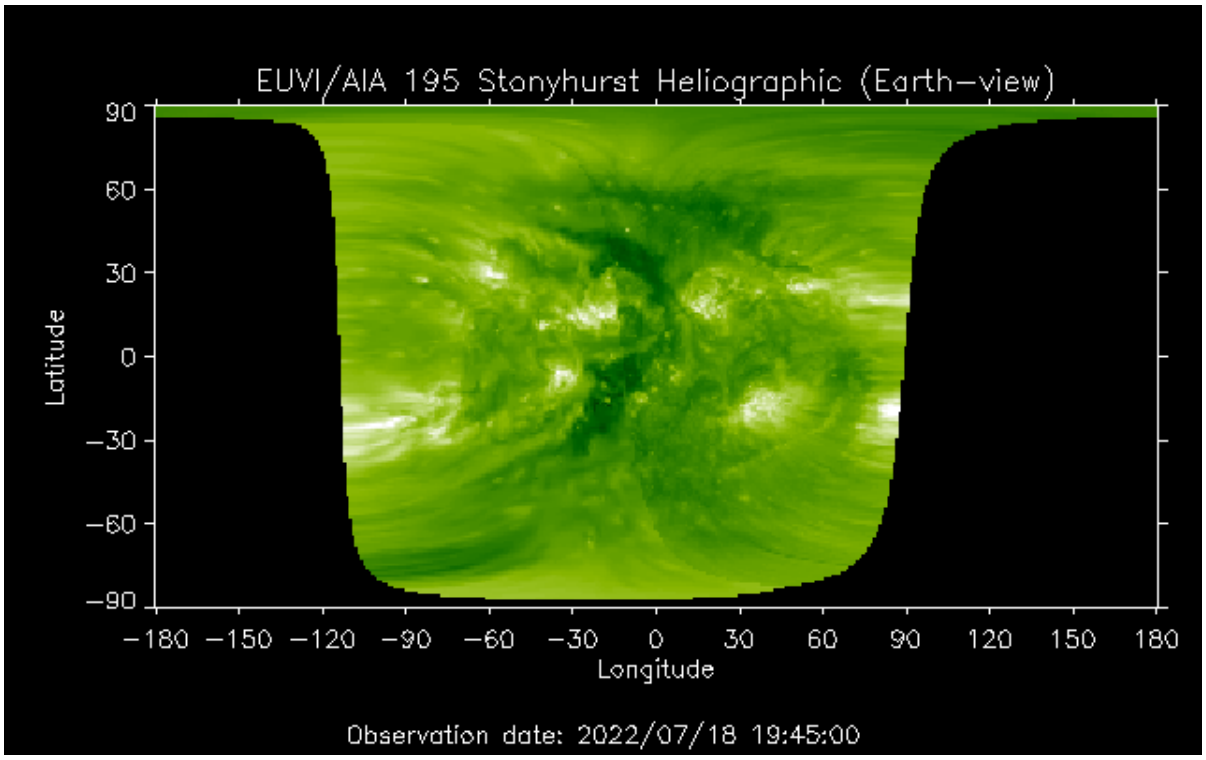
Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours, with the Sun apparently entering a lull in activity, or at least presenting its far less active side at present. The current disc is the preserve of minor bipolar and unipolar regions, and barring significant development, it is difficult to envisage a likely source of significant activity as a result. The only departure expected in the four days is AR3057, which is currently showing only minor activity and unlikely to significantly dent the prospects of flares.

The far side is currently far more congested, with the Carrington locations of Ex-regions 3046-2051 inclusive due over the eastern limb in the coming four days, although there is little of note on available STEREO A imagery at present - the southeastern limb perhaps excepted.
All considered, solar activity is Likely to remain Low, with a Slight Chance of Moderate activity, possibly increasing into the new week dependent on arrivals.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: Cylindrical projection of the whole sun in 195 Angstroms, showing a possible bright flux region due over the southeastern limb, but otherwise a largely benign disc.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. As most regions are small and relatively magnetically simple, the risk of a proton enhancement is very low.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux is now expected to suffer a period of suppression and redistribution in the wake of the 23/0300UTC arrival of the expected 21 July CME. The degree to which recovery occurs is perhaps dependent on whether CH01 and CH02 are still in course at the point where the CME fades.

The persistence forecast alone would have fluence rising at the present time given the influence of the predecessors of CH01 and Ch02 27 days ago, however the presence of the CME effects renders this unreliable, and the odds of Active fluence are therefore lessened, with much larger error bars. All considered, there is perhaps a Chance of Active by the start of the new working week (UTC).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	30	40	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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